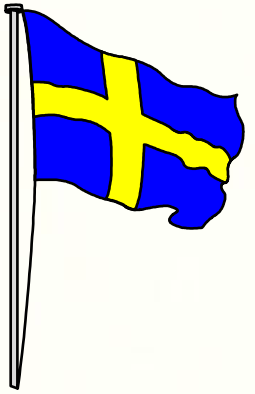


Soldier Lethality and Wound Ballistics from a Swedish Perspective

Presentation to

"NDIA 51st Joint Services Small Arms Symposium"

Atlantic City, May 18, 2005

Per G. Arvidsson

Product Manager Small Arms Systems

Swedish Armed Forces Materiel Command

Tel: +46-8-782 4181, Fax: +46-8-782 6412

E-mail: per.arvidsson@fmv.se

Web-site: www.fmv.se

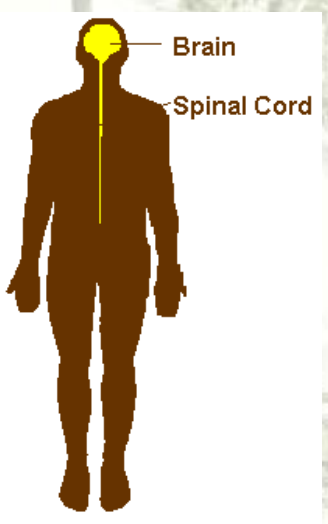
FMV

Agenda

- Wound ballistics.
- Small arms lethality.

Two ways to incapacitate

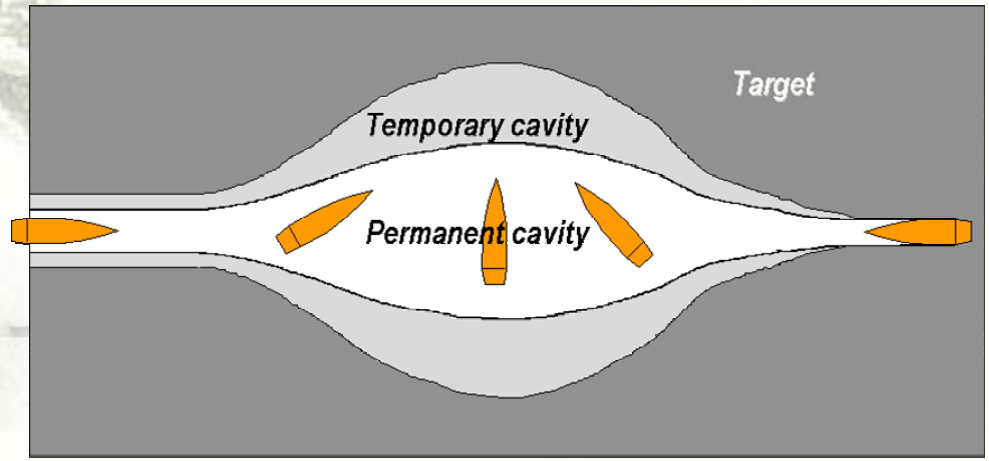
1. Hit to the central nervous system.
   - Immediate incapacitation regardless of caliber or type of projectile!
2. Loss of blood pressure by massive bleeding.
   - This happens if the projectile can create a large wound.
   - The projectile has to have:
     - High kinetic energy (velocity and mass).
     - Large braking area (large caliber, expanding or fragmenting projectile).
     - Large penetration.
   - Incapacitation can take time!



FMV

Wound ballistics

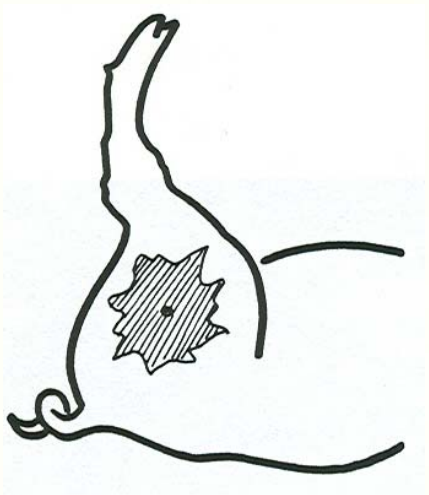
- Energy dump in the target is an indication that ”work” has been done.
- This ”work” means that a temporary and permanent cavity has been created.
- The temporary cavity is caused by the hydrodynamic shock wave.
- The permanent cavity represents the destroyed tissue.



FMV

Swedish wound ballistic research

- Large study in the 1970's concluded that human and pig muscles were similar.
- Wound ballistic research was done on anesthetized pigs.
- These are still used for medical training in Sweden.

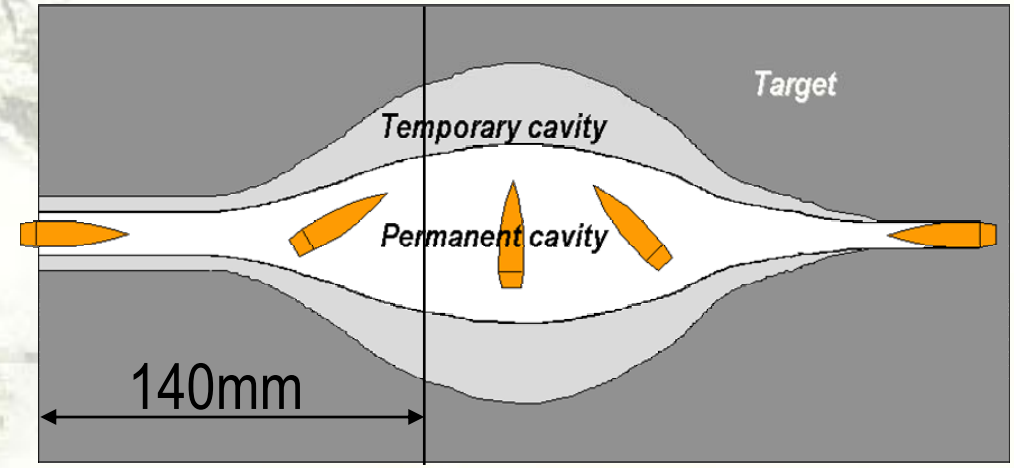


Test medias

- Wood
- Water soaked paper
- Plasticine
- Clay
- Water
- **Gelatin**
- **Soap**

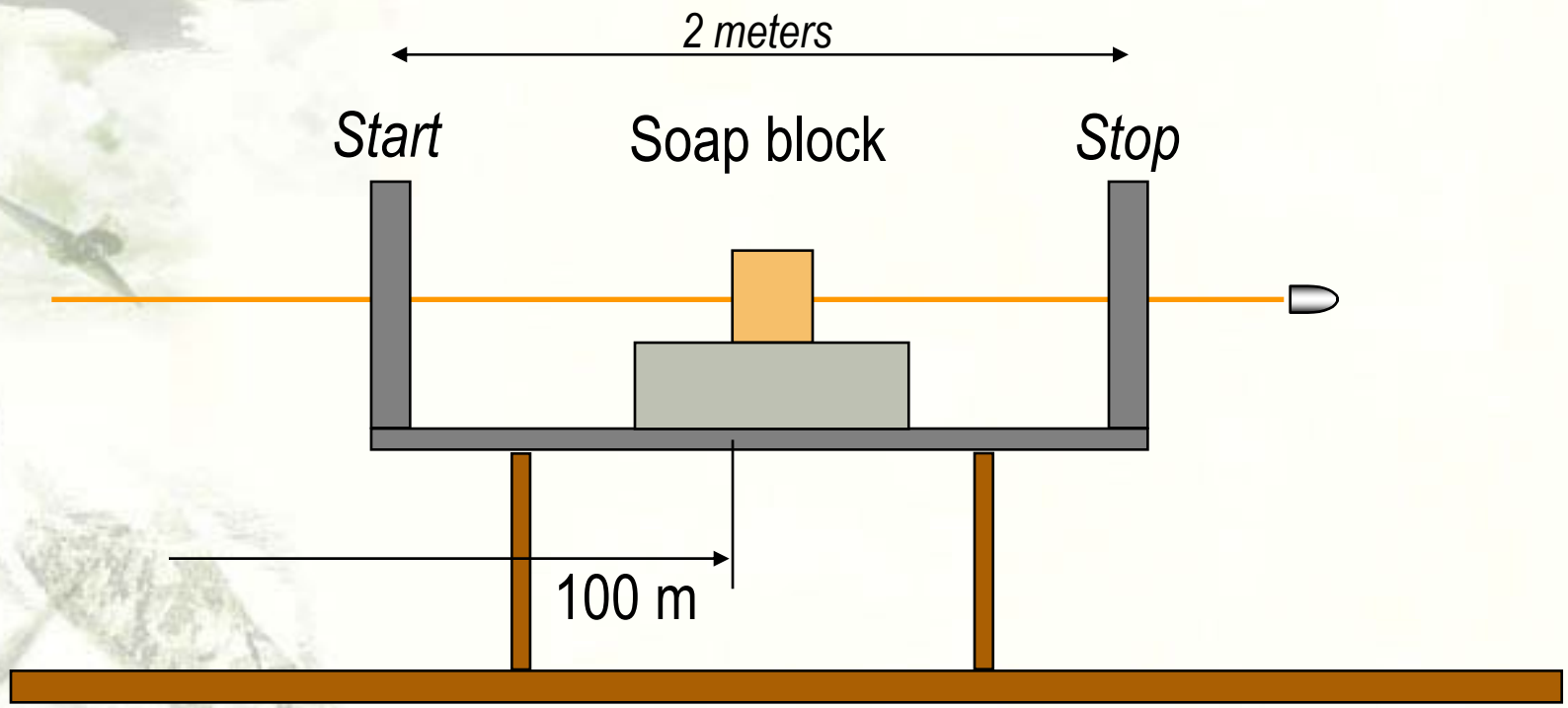
Swedish ballistic soap

- In Sweden we use ballistic soap as a test media.
- It shows the temporary cavity.
- Swedish research has concluded that 140mm of ballistic soap corresponds to the amount of human tissue destroyed if the target is hit from the frontal arc.



FMV

Soap block ballistic test setup



The impact and exit velocities are recorded, and the energy dump is calculated.

Energy dump in 140mm soap at 100m

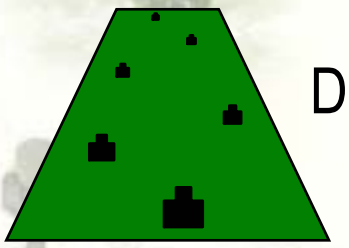
Typical values:

- 5.56 NATO: 180J
- 7.62 NATO: 250J

In tissue this would be the temporary cavity. The diameter corresponds to the dumped energy at that point.

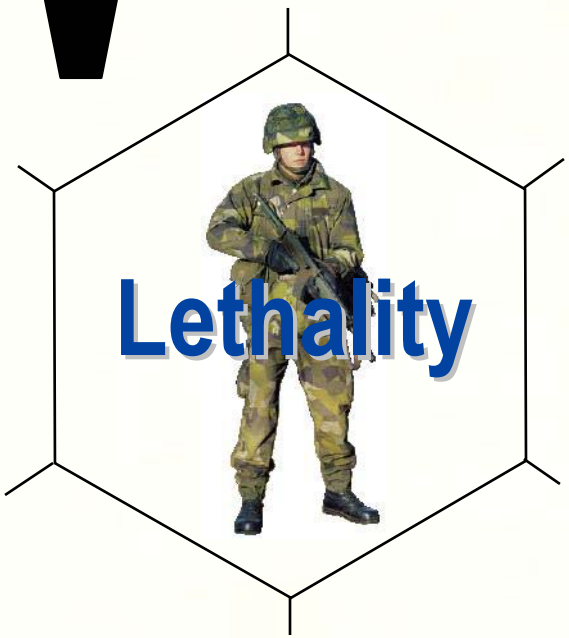
Small arms lethality

Shot placement



Distance

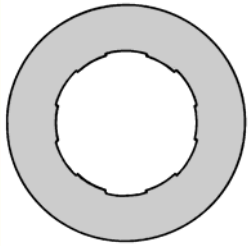
Target



Ammunition

Weapon

Caliber



FMV

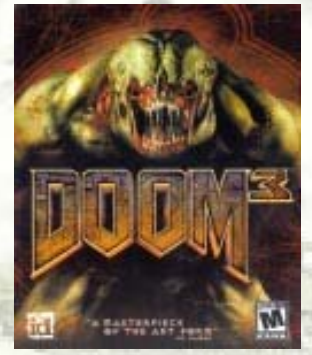
Shot placement

The single most important factor!

”80%”

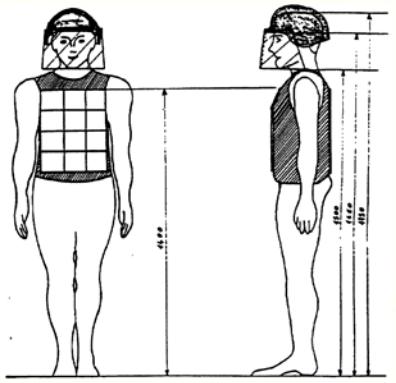
Movies and computer games…

- By watching movies and playing computer games some soldiers believe that a hit anywhere will bring the enemy down…
- …and that he will stay down!



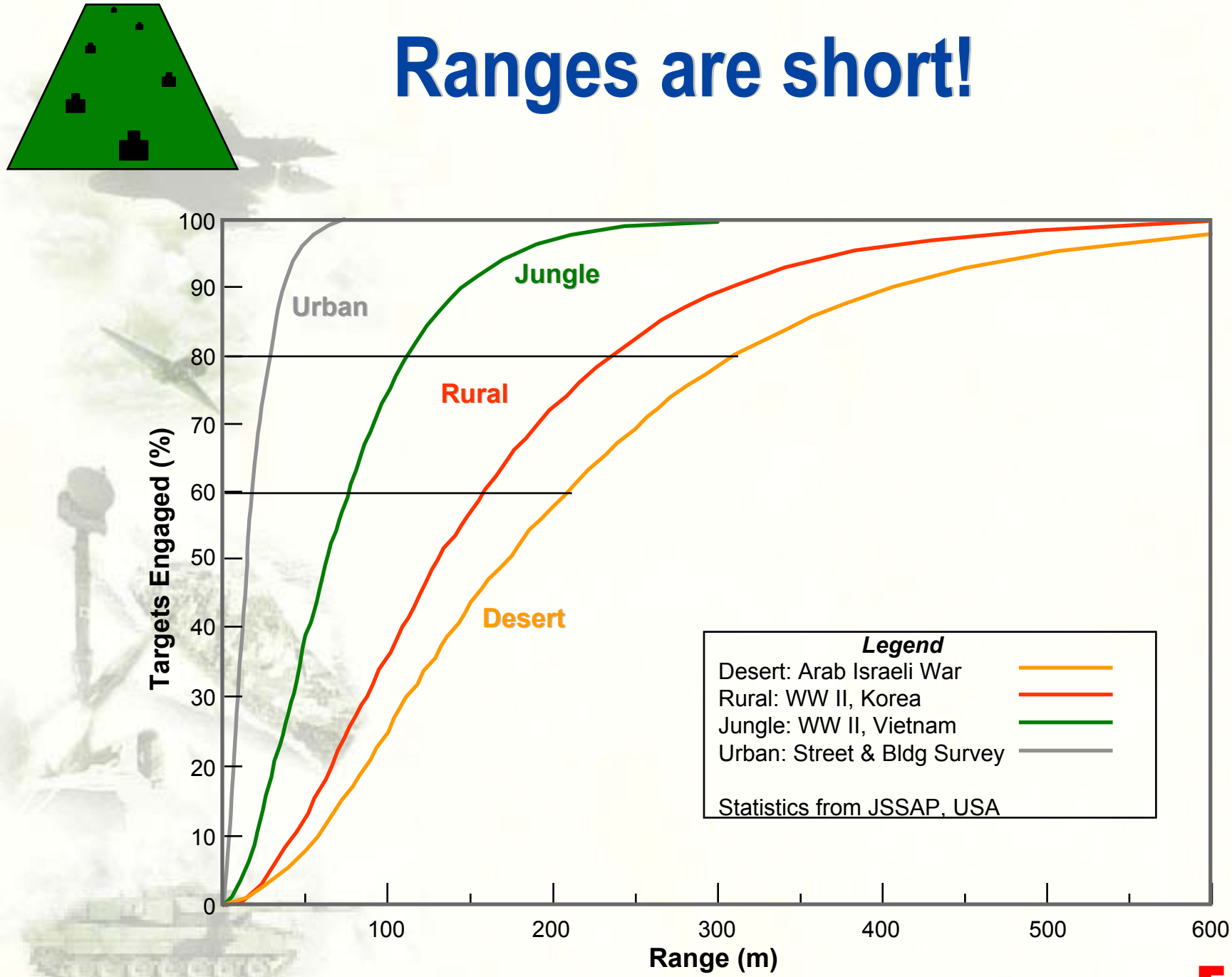
FMV

Target



- Size.
- Motivation.
- Protection (body armor).

Ranges are short!



Information from the NATO Infantry Weaponry Master Plan 2004

FMV

USMC after action report from Iraq

- Engagements conducted with small arms occurred in the 20-30m range.
- Shots over 100m were rare.
- The maximum range was less than 300m.

Information from the NATO Infantry Weaponry Master Plan 2004

FMV

Weapon

- Barrel length (muzzle velocity).
- Rifling twist.

US M4A1

SWE Ak 5C

GE G36K

GE G36C

FMV

Future individual weapons

- Evolution – no revolution!
- Caliber 5.56 NATO.
- Mil-Std-1913 rail.
- Red-dot sight.
- Short barrel.

SWE Ak5C

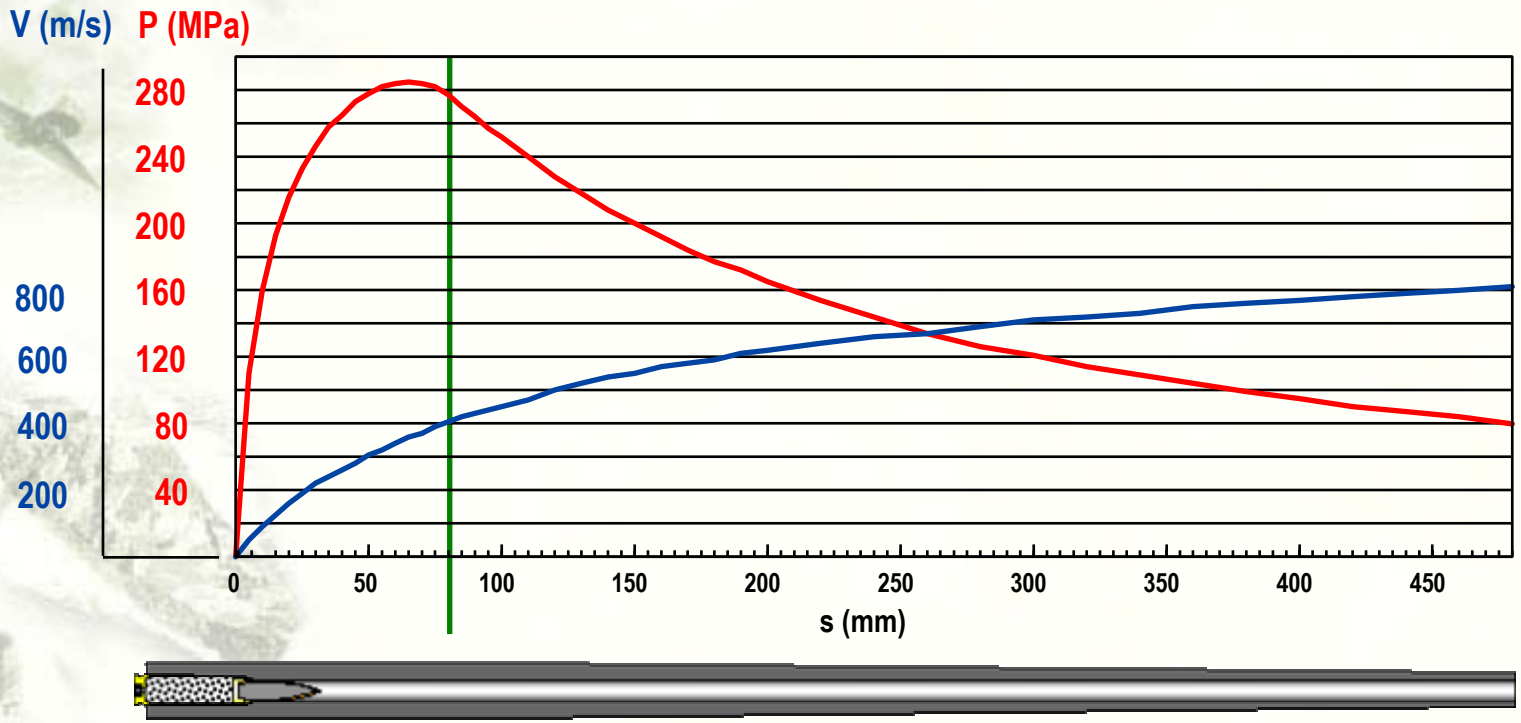
GE G36K

US Mk16

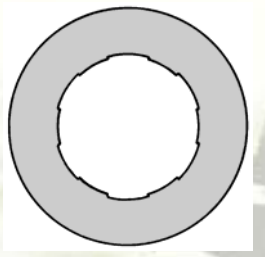
Information from the NATO Infantry Weaponry Master Plan 2004

FMV

Inner ballistics

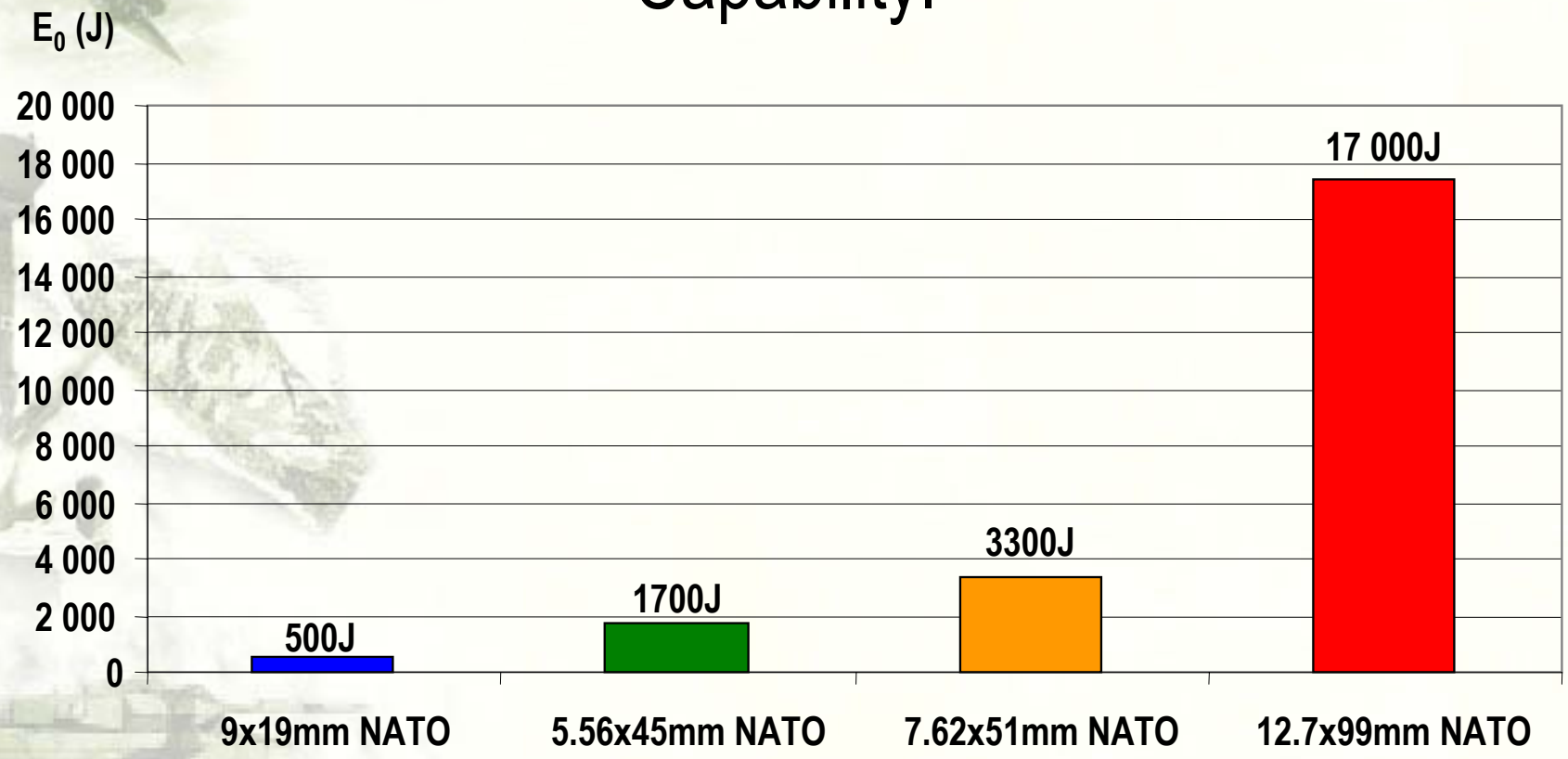


50% of V_0 within 80mm (3”)!



Caliber

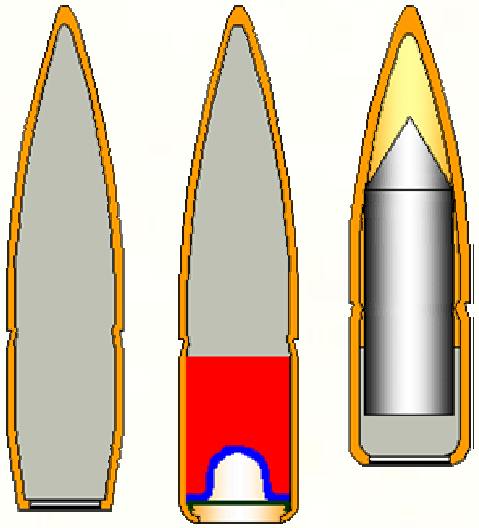
- Energy.
- Capability.



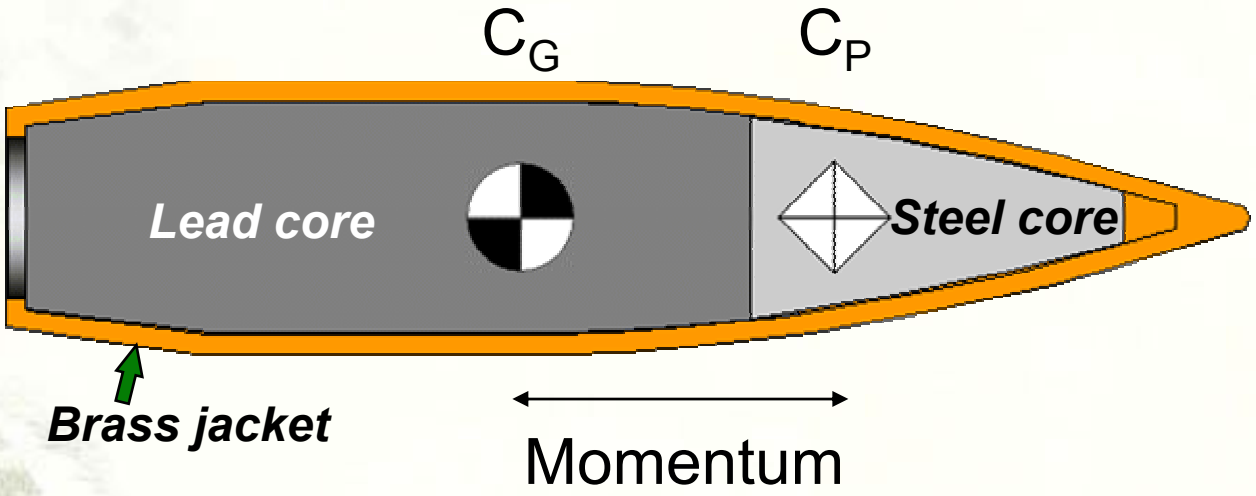
FMV

Ammunition

- Projectile:
  - Type:
    - FMJ
    - Tracer
    - AP
  - Mass
  - Velocity
- Stability.
- Fragmentation.



5.56 NATO (FN SS109/US M855)

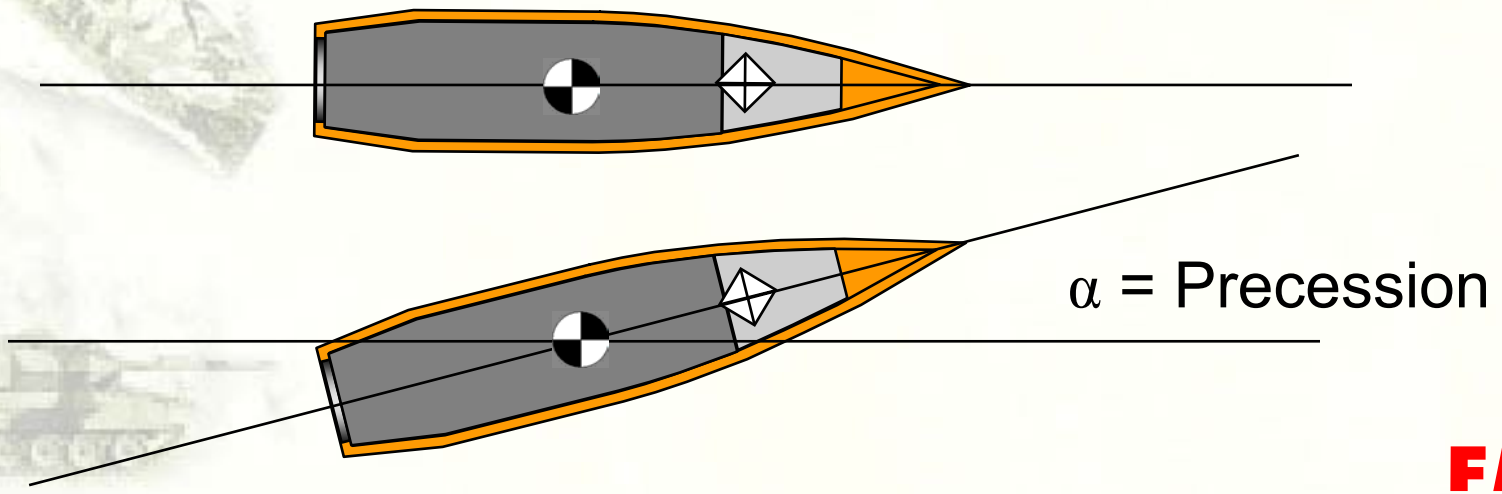


Basic data:

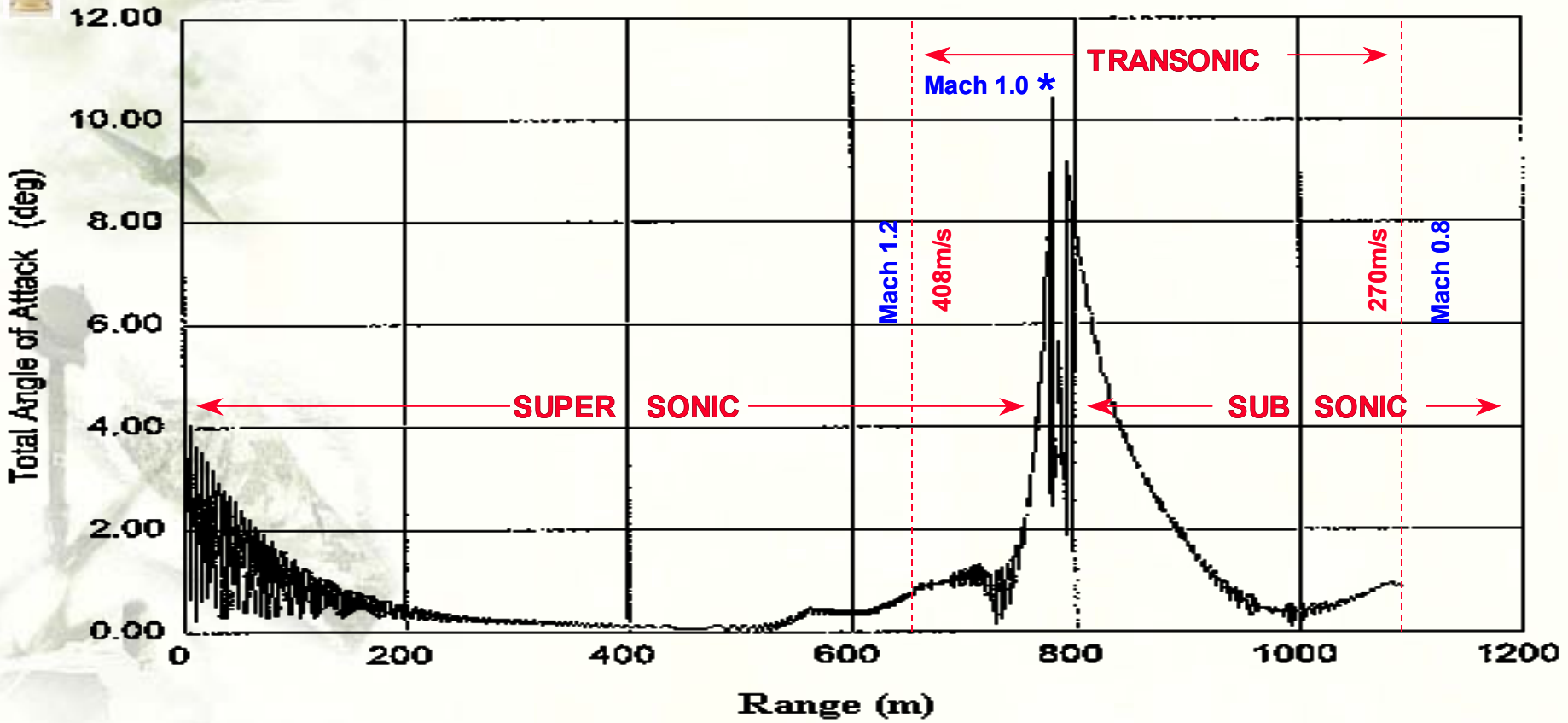
- V_0 = 930 m/s
- m_P = 4.0 g
- S = 1/7” (1/178mm)

Projectile yaw angle

- Projectile in flight = Spinning top!
- Three phases:
  1. Large initial yaw angle = precession.
  2. Stable.
  3. Tilt.



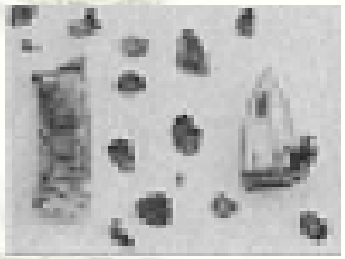
Yaw characteristics
5.56 NATO



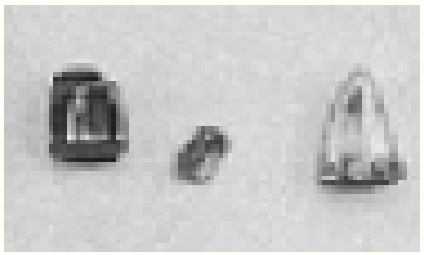
Total angle of attack; maximum yaw amplitude = 10.4 degrees

Fragmentation

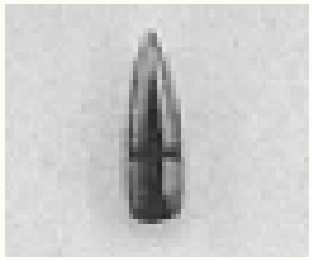
- If the velocity is high enough the projectile can fragment.
- This creates fragments that work like secondary projectiles, which creates a larger wound channel.
- For the 5.56 NATO projectile the threshold velocity for fragmentation is approx. 760 m/s (2500 fps).



890 m/s
(2900 fps)



760 m/s
(2500 fps)



650 m/s
(2100 fps)

Swedish error budget study

- Shooting errors (”SARA”).
- Weapon and ammunition.
- Range estimation.
- Target lead.
- Shooting uphill or downhill.
- Temperature difference.
- Drift due to rotation.
- Wind.

S=Position
A=Breathing
R=Aiming
A=Trigger pull

FMV

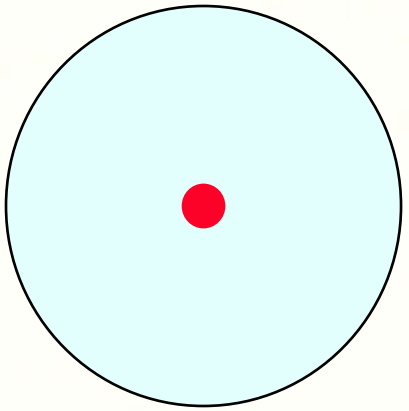
Results: two scenarios

- Short range (< 100m):
  - Shooting errors (”SARA”).
  - Target lead.
- Long range (> 100m):
  - Shooting errors (”SARA”).
  - Target lead.
  - Range.
  - Wind.

S=Position
A=Breathing
R=Aiming
A=Trigger pull

How to improve shot placement

- Proper basic shooting training (”SARA”).
- Realistic combat training!
- Good sights.
- Smaller targets.

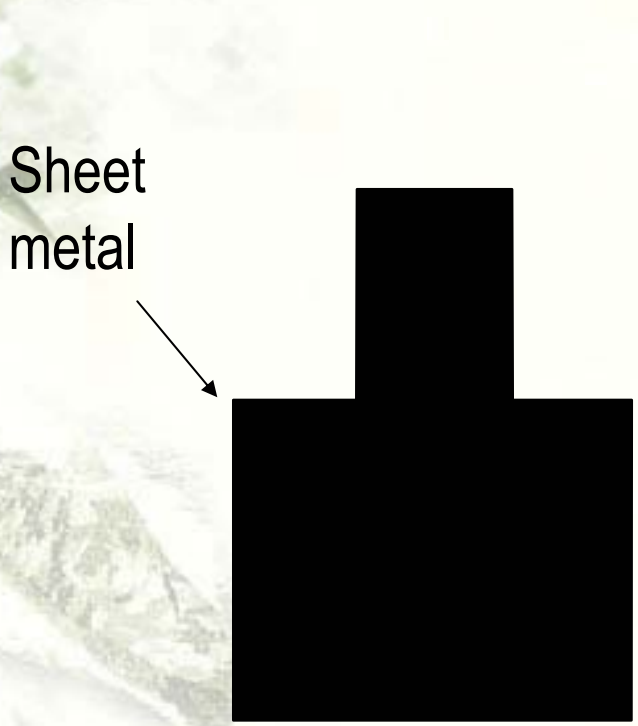


S=Position
A=Breathing
R=Aiming
A=Trigger pull

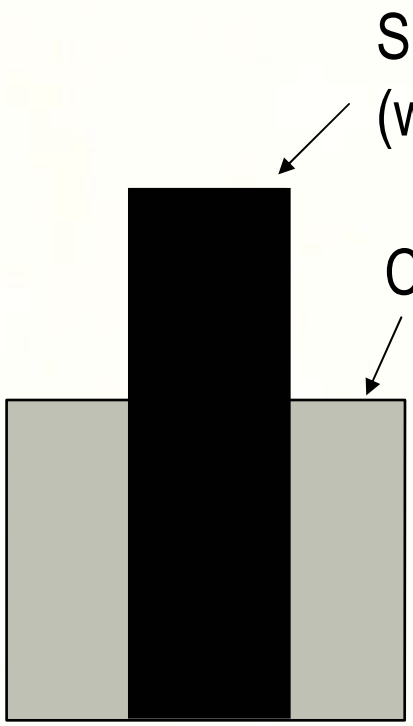
SWE Aimpoint CS Red-Dot Sight

FMV

New Swedish pop-up target



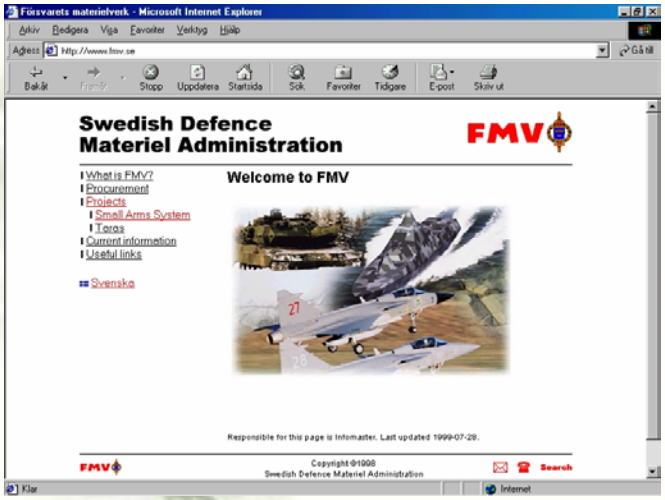
Original
target



Modified target

Summary

- Shot placement is the key to lethality!
- Proper shot placement is reached by basic shooting training, and realistic combat training!



Questions?

Visit our web site at www.fmv.se

FMV